

- Slodkewitsch, W. S. 1938. Tertiary Pelecypoda from the Far East, Pt. 2. U.S.S.R. Acad. Sci. Paleontol. Inst., Paleontol. of U.S.S.R., 10 (3): 1-275.
- Stirton, R. A. 1952. Are Petaluma horse teeth reliable in correlation? Bull. Amer. Assoc. Petrol. Geol., 36:2011-2025.
- Stoliczka, F. 1870-1871. Cretaceous fauna of southern India. Vol. III. The Pelecypoda, with a review of all known genera of this class, fossil and Recent. Mem. Geol. Soc. India, Palaeontol. Indica, ser. 6, 3:1-537 [pp. 1-222 issued 1870; 223-537, 1871].
- Travis, R. B. 1952. Geology of the Sebastopol quadrangle, California. California Div. Mines Bull., 162:1-33.
- Valentine, J. W. 1966. Numerical analysis of marine molluscan ranges on the extratropical northeastern Pacific shelf. Limnol. Oceanogr., 11:198-211.
- Weaver, C. E. 1949. Geology of the coast ranges immediately north of the San Francisco Bay region, California. Mem. Geol. Soc. America, 35:1-242.
- Winckworth, R. 1935. Notes on nomenclature. Proc. Malacol. Soc. London, 21:321-324.
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TWO NEW SPECIES OF LAND SNAILS FROM THE PINALENO MOUNTAINS, ARIZONA

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ABSTRACT: Two new species of land snails are described from the Pinaleno Mountains in southeastern Arizona.

The Pinaleno Mountains, sometimes called the Graham Mountains, lie in line with the Chiricahua system in southeastern Arizona and are separated from the northern end of the Dos Cabezas Mountains by a wide mesa. The Pinalenos have long been neglected by malacologists. A brief account is given (Pilsbry and Ferriss, Proc. Acad. Nat. Sci. Philadelphia, for 1918: 282-334, 1919) of a collecting trip made by Ferriss, 14 October 1913, "Besides *Sonorella* and *Oreohelix*, *Vitrina alaskana* was abundant and two young Vallonias were found." Pilsbry and Ferriss described *Sonorella grahamensis* from this material but there was no further mention of the *Oreohelix*.

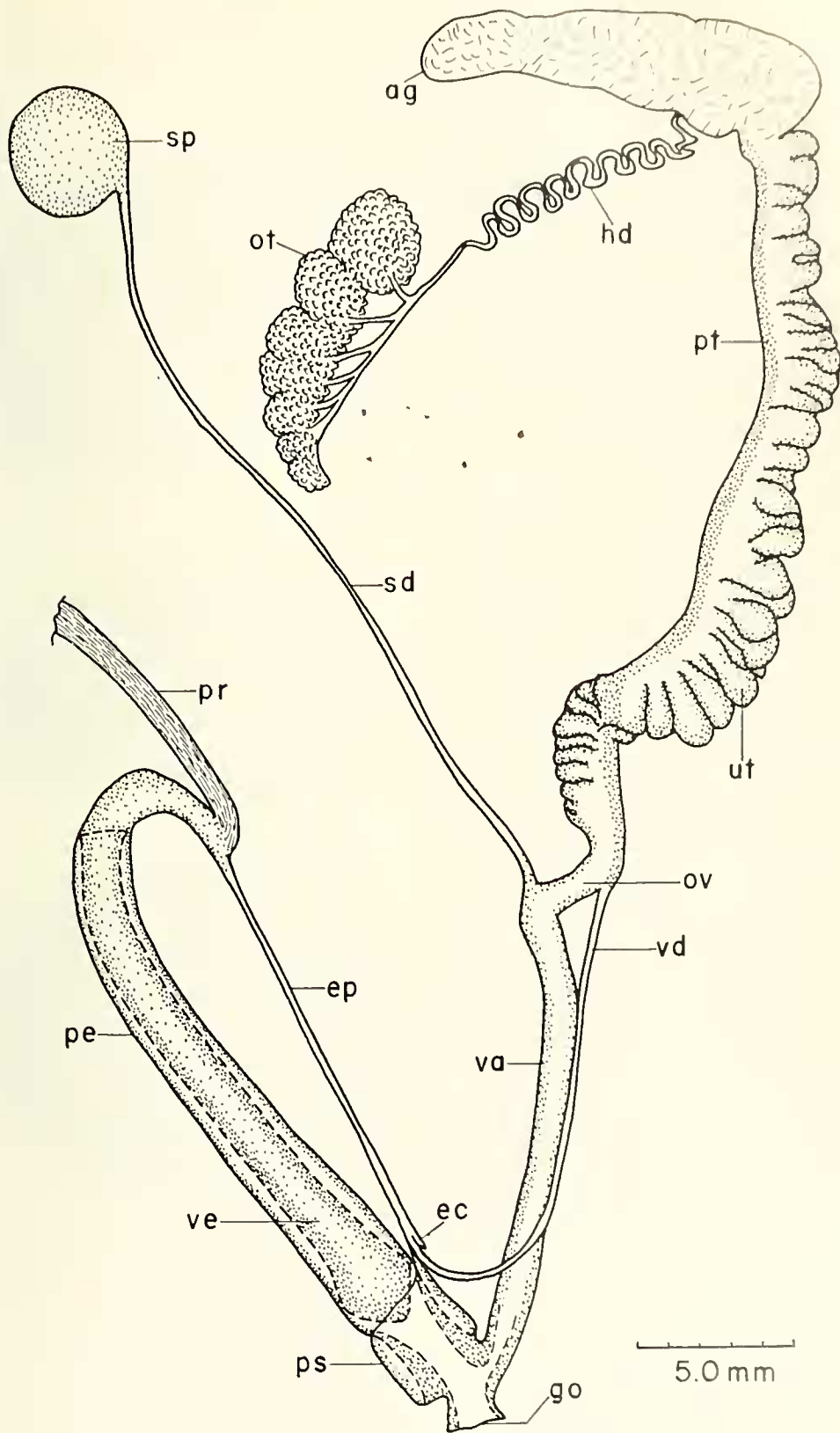
On 21 April 1954, M. L. Walton and one of us (Gregg) visited the Pinaleno Mountains.

Leaving Safford on US highway 666, we traveled south seven miles, then turned west on the "Swift Trail," now a well-maintained mountain road. We continued about 20 miles which took us to near 9000 feet altitude. Stopping now and then to look for snails, we found *Sonorella* and *Oreohelix* and in the same microhabitat, *Microphysula ingersolli meridionalis* (Pilsbry and Ferriss), *Retinella indentata paucilirata* (Morelet), *Zonitoides arboreus* (Say), *Striatura meridionalis* (Pilsbry and Ferriss), *Deroceras* sp., *Discus*

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Figure 1. *Sonorella imitator*, new species. Genitalia drawing made from projection of stained whole mount: ag, albumin gland; ec, epiphallallic caecum; ep, epiphallus; go, genital orifice; hd, hermaphroditic duct; ot, ovotestes; ov, oviduct; pe, penis; pr, penial retractor; ps, penial sheath; pt, prostate; sd, spermathecal duct; sp, spermatheca; ta, talon; ut, uterus; va, vagina; vd, vas deferens; ve, verge.



cronkhitei (Newcomb), *Punctum californicum* Pilsbry, and *Vertigo gouldi arizonensis* Pilsbry. These snails were found under isolated rocks; no definite rockslides were present. The *Oreohelix* from this locality immediately appeared to be different from any described species. The *Sonorella* specimens appeared to be *S. grahamensis* Pilsbry and Ferriss but subsequent dissection revealed two distinct species, *S. grahamensis* and an undescribed species, both sympatric in the same microhabitat. The new *Oreohelix* and the new *Sonorella* are described below. All measurements are given in millimeters.

FAMILY HELMINTHOGLYPTIDAE

Sonorella imitator, new species

Figures 1 and 2

This name was cited as a nomen nudum by Bequaert and Miller, *The Mollusks of the Arid Southwest*, p. 117, 1973.

Diagnosis.—A species of moderate size, finely striate body whorl, characterized anatomically by a very long verge and a short oviduct.

Description of Holotype.—Shell heliciform, depressed conic, whorls four and one half, increasing gradually to the last whorl which is moderately expanded and descends behind the aperture so that the last one eighth of the body whorl lies at an angle of about 25 degrees with the transverse axis of the shell. Whorls convex, flattened above, rounded on the base. Aperture rounded-oval and lying at an angle of about 45 degrees with the vertical axis. Peristome very slightly expanded, not appreciably thickened, and with a thin parietal callus; the columellar end of the peristome slightly reflected over the margin of the umbilicus. Width of the umbilicus contained about seven times in the greater diameter of the shell. Surface glossy, color light sayal brown, lighter on the base and on each side of the peripheral chestnut brown band. Embryonic shell consists of one and one half whorl, apex smooth, followed by indistinct radial wrinkling which continues over the remainder of the embryonic portion of the shell and as far as the first half of the penultimate whorl where it is replaced by delicate growth lines. Early whorls have a minutely granulose appearance with here and there suggestions of papillae which have been nearly effaced by erosion. There are numerous impressed spiral lines on the upper surface of the body whorl and on the last half of the base of the body whorl.

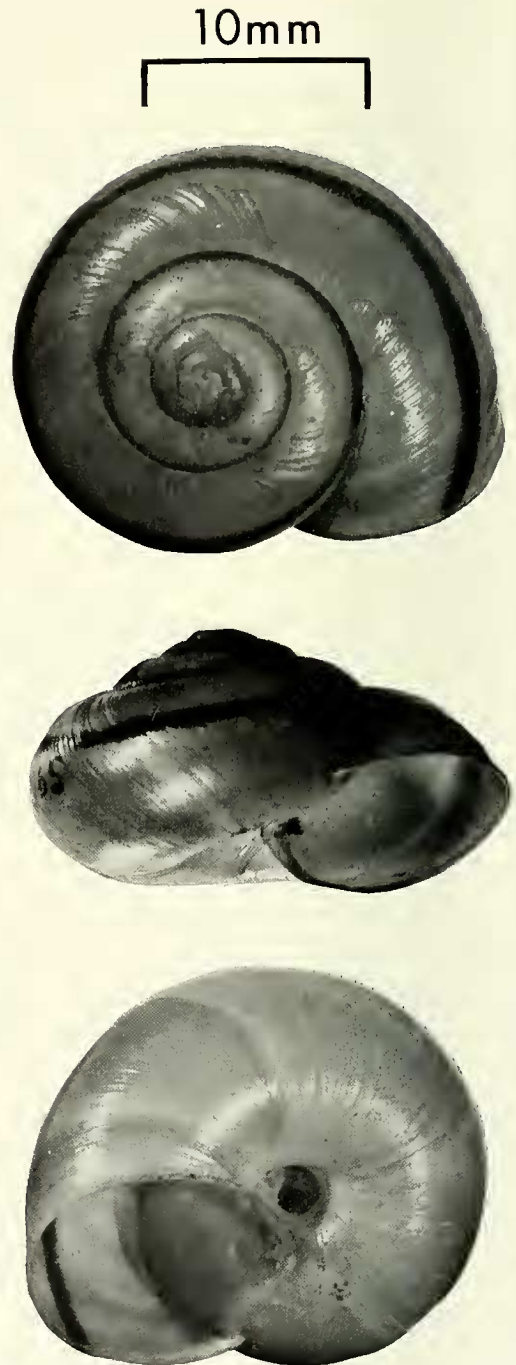
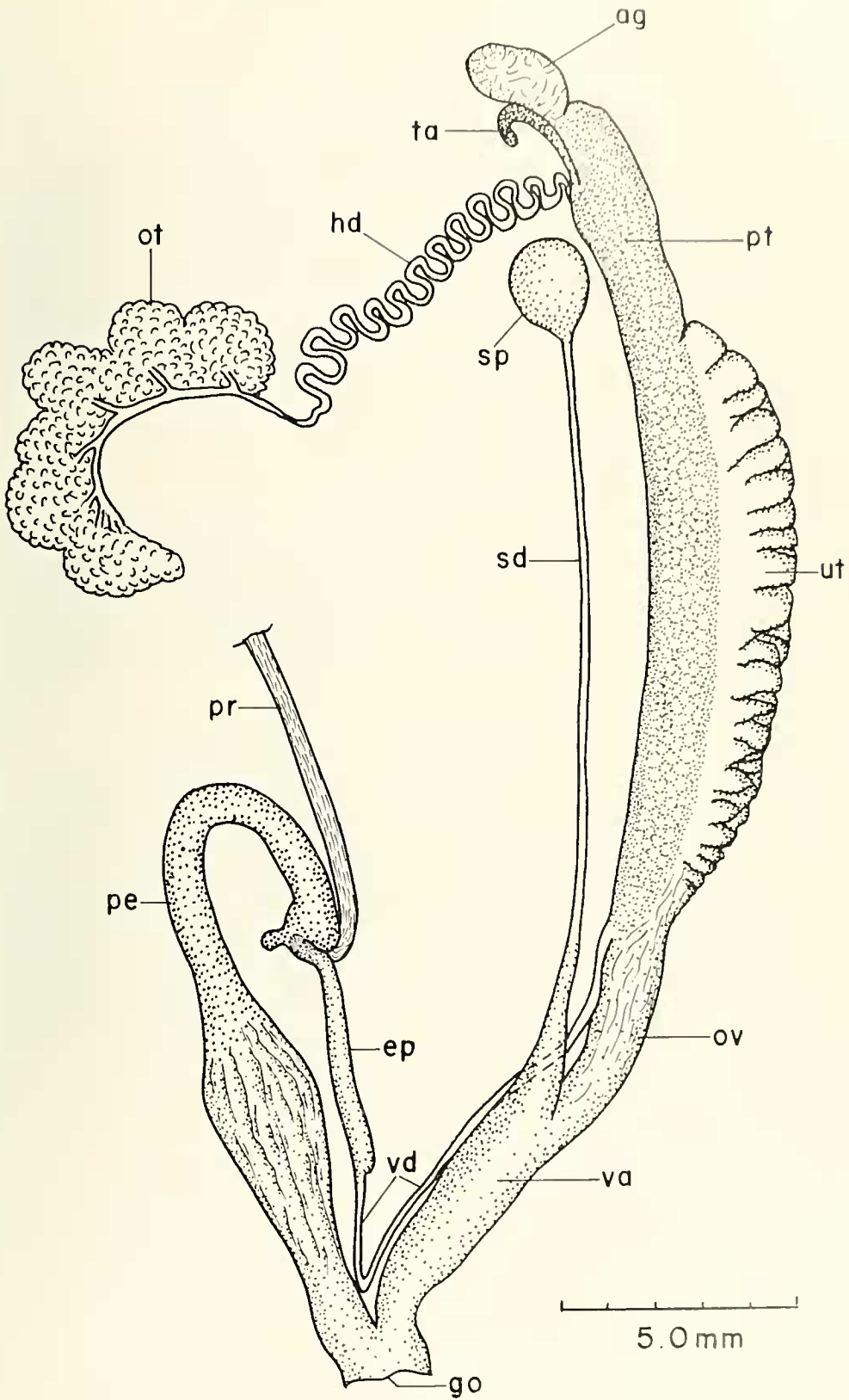


Figure 2. *Sonorella imitator*, new species, three views.

Figure 3. *Oreohelix grahamensis*, new species. Genitalia drawing made from projection of stained whole mount. See figure 1 for key to abbreviations.



Height of holotype 12.0, diameter 21.8, umbilicus 3.0. Average of 17 paratypes: Height 12.2, diameter 21.9, umbilicus 3.0.

Genitalia.—The penis (Fig. 1) is about equal in length to the diameter of the shell and contains a large verge nearly as long as the penis. The verge gradually widens to a blunt distal end. Penis sheath short, penial retractor muscle inserted at the junction of the penis and epiphallus, epiphallus about half the length of the penis and bears at its proximal end a very short epiphallic caecum which is adnate to the adjacent portion of the vas deferens, oviduct very short. Measurements of genital structures: penis 20.8, penis sheath 5.4, verge 18.1, epiphallus 9.3, epiphallic caecum 1.3, penial retractor 7.4, vagina 12.5, oviduct 2.8, spermathecal duct 15.5, spermatheca 2.9×2.9 , atrium 1.4.

Type Locality.—South slope of Mt. Graham, Pinaleno Mountains, Graham Co., Arizona; along "Swift Trail" highway, on north side, at a point 20.7 road miles from its beginning at US highway 666; elevation ca. 9000 feet, collectors M. L. Walton and W. O. Gregg, 21 April 1954.

Type Material.—Holotype, Natural History Museum of Los Angeles County No. 1154. Paratypes: California Acad. Sci., Dept. Geol. No. 12948, San Diego Nat. Hist. Museum, invertebrate type coll. 2545, and private collections of S. S. Berry 31923, W. O. Gregg 8755, W. B. Miller 5357, and M. L. Walton 9279.

Remarks.—On four paratypes which apparently represent senile specimens the peristome is slightly thickened and the parietal callus is moderately thickened. These snails were associated with *Sonorella grahamensis* Pilsbry, from which they are indistinguishable on casual examination. A more careful examination reveals that they fall into two separate size groups, *S. grahamensis* with an average diameter of 19.2 (14 specimens measured), *S. imitator* 21.9 (average 17 paratypes). The latter has a more expanded body whorl which is more flattened above. The penial length of *Sonorella imitator* is approximately equal to the width of the shell; it has a long, robust, blunt-tipped verge occupying nearly the entire length of the penis cavity, whereas *S. grahamensis* has a penis about half as long as the diameter of the shell with a shorter verge which tapers to an acute tip. The oviduct is short in *S. imitator* whereas that of *S. grahamensis* exceeds the length of the verge. The genital anatomy of *S. imitator* closely resembles that of *S. ambigua* Pilsbry and Ferriss and *S. ambigua verdensis* Pilsbry, but the shell sculptures are considerably different. Accordingly, the authors consider the similarity of genital anatomy to be simply a case of convergent evolution.

Sonorella imitator has also been found on Heliograph Peak in the Pinaleno Mountains (Bequaert and Miller, *The Mollusks of the Arid Southwest*, p. 117, 1973) where it is relatively common, in association with *S. grahamensis*, at the 10,000 foot level. At lower elevations, however, such as along Wet Creek at the 6300 foot level where *S. grahamensis* is abundant, *S. imitator* is absent. It is apparently restricted to the high elevations of the Pinalenos, ca 9000 feet and above.

FAMILY OREOHELICIDAE

Oreohelix grahamensis, new species

Figures 3 and 4

This name was cited as a nomen nudum for a subspecies of *Oreohelix concentrata* (Dall) by Bequaert and Miller, *The Mollusks of the Arid Southwest*, p. 127, 1973.

Diagnosis.—A moderate-sized species of the *O. yavapai*-group, with closely set spirals on the body whorl, rather prominent lines of growth, and a prominent cornuate process at the proximal end of the penis.

Description of Holotype.—Shell of moderate size, low-conic, widely umbilicate. Whorls five and one half, gradually increasing in size, convex above and below the periphery which is rounded on the last three fourths of the body whorl, a slight keel persisting in the first quarter of the body whorl. The last quarter of the body whorl descends slightly below the strongly keeled periphery of the penultimate whorl. Peristome subcircular, simple, with a thin parietal callus. Aperture lying at an angle of about 45 degrees with the vertical axis of the shell. All whorls visible in the umbilicus which is contained about four times in the greater diameter of the shell. Embryonic shell consists of two and one eighth whorls and is about 4 mm in diameter. First whorl smooth (eroded); traces of growth lines appear on the second whorl at somewhat irregular intervals and continue over the remainder of the shell. Fine spirals appear on the third whorl and continue nearly to the aperture. These spirals are closely set and regular on portions of the shell whereas at intervals they are interrupted by lines of growth; are less closely spaced over the rounded base of the body whorl and are clearly visible in the umbilicus. The coiling is somewhat irregular and in places the suture descends beneath the acute keel of the earlier whorl. On portions of the shell there are traces of a peripheral cord.

Color light snuff brown above, much lighter on the base, with a chestnut band about 1 mm wide above the periphery and another band of the same color



Figure 4. *Oreohelix grahamensis*, new species, three views.

and somewhat wider just below the periphery. Height 10.8, diameter 20.0, umbilicus 5.0.

On uneroded specimens the spirals appear on the last half of the second whorl and the radial lines appear on the first whorl. On some specimens the peripheral cord is continuous though variable.

Genitalia.—Internally ribbed portion of penis (Fig. 3) is more than half the total length of the penis; epiphallus spindle shaped and bulbously expanded; epiphallus spindle shaped and half the length of the penis. In stained and cleared specimens, the distal end of the epiphallus is seen to protrude into the upper end of the penis cavity, giving the appearance of a short verge. On the opposite side of this verge-like structure, the proximal end of the penis bears a prominent cornuate projection. These characters of penis and epiphallus are constant in all five anatomies examined. Albumin gland rather small; "talon" well-developed, black. Measurements of genital structures: penis 21.4, internally ribbed portion 12.0, epiphallus 9.1, penial retractor 8.8, vagina 6.6, oviduct 5.6, spermathecal duct 21.5, spermatheca 1.1×1.5 .

Type Locality.—South slope of Mt. Graham, Pinaleno Mountains, Graham Co., Arizona; along "Swift Trail" highway, on north side, at a point 20.7 road miles from its beginning at US highway 666; elevation ca. 9000 feet, collectors M. L. Walton and W. O. Gregg, 21 April 1954.

Type Material.—Holotype, Natural History Museum of Los Angeles County No. 1155. Paratypes: California Acad. Sci., Dept. Geol. No. 12947, Field Museum Nat. Hist. 109587, San Diego Nat. Hist. Museum, invertebrate type coll. 2546, and private collections of S. S. Berry 31922, W. O. Gregg 7038, W. B. Miller 4831, M. L. Walton 6844.

Remarks.—The characteristics of the penis place *O. grahamensis* in the *Oreohelix yavapai*-group of *Oreohelix sensu stricto* (Pilsbry, Acad. Nat. Sci. Philadelphia, Monograph 3, vol. 1(1): 573, 1939). *Oreohelix grahamensis* is most closely related to the *O. concentrata*-complex. From typical *O. concentrata* (Dall), *O. grahamensis* is distinguished by its wider umbilicus, more elevated spire, spiral striation and uniformity of coloration.

Bequaert and Miller (The Mollusks of the Arid Southwest, p. 127, 1973) considered that the populations of *Oreohelix* from the Pinaleno Mountains were only subspecifically distinct from *Oreohelix concentrata* populations in the Huachuca Mountains. Careful comparison of anatomical and shell features as well as consideration of prolonged and extensive geographical isolation have convinced the authors that the genetic heterogeneity which has developed between the populations of these two mountain ranges is most probably sufficient to cause reproductive isolation. Accordingly, *Oreohelix grahamensis* is considered to be a distinct species.

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